SPECIFICATIONS

VRTS with 4 GHz Bandwidth

Automotive Radar Measurement and Object-Simulation System

These specifications apply to simulation and measurement using the VRTS with 4 GHz Bandwidth.

The Vehicle Radar Test System (VRTS) with 4 GHz Bandwidth comprises the following modules:

- PXIe-5551 Variable Delay Generator
- mmRH-5591 mmWave Radio Head
- PXIe-5841 Vector Signal Transceiver (optional)
- PXI Express Chassis
- PXI Express Controller

In this document, the term *system* describes the above modules assembled as described in the VRTS with 4 GHz Bandwidth Getting Started Guide. There is no single system component labeled “VRTS with 4 GHz Bandwidth” .

Note Reference the specifications document for your PXIe-5841, PXI Express Chassis, and PXI Express Controller for more information on these components of the VRTS with 4 GHz Bandwidth.

Contents

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty. Warranted specifications account for

measurement uncertainties, temperature drift, and aging. Warranted specifications are ensured by design or verified during production and calibration.

Characteristics describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- *Typical* specifications describe the performance met by a majority of models.
- *Typical-95* specifications describe the performance met by 95% (≈2σ) of models with a 95% confidence.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.
- *Measured* specifications describe the measured performance of a representative model.

Specifications are *Warranted* unless otherwise noted.

Conditions

Warranted specifications are valid under the following conditions unless otherwise noted.

For all configurations:

- 30 minutes warm-up time
- Calibration cycle is maintained
- The chassis fan mode is set to Auto when used in a chassis with ≥58 W slot-cooling capability or the fan mode is set to High when used in any other chassis
- Empty chassis slots contain slot blockers and EMC filler panels to minimize temperature drift and reduce emissions
- Modules are connected with cables of the appropriate length:
  - 0.15 m cables to connect PXIe-5551 modules to other PXIe-5551
  - 0.15 m cables to connect PXIe-5551 modules to PXIe-5841 modules
  - 0.46 m cables to connect mmRH-5591 devices to PXIe-5551 modules

Typical specifications do not include measurement uncertainty. For measurement applications, typical specifications are measured immediately after a PXIe-5841 self-calibration is performed.

The following specifications apply to configurations with 1 to 2 objects per radio head. The system is capable of simulating up to 4 objects per radio head.

mmRH-5591 RF Characteristics

RX	
Connector	WR-12, UG387/U, horizontal polarization
Recommended maximum input power (at the waveguide flange)	-13 dBm
Absolute maximum input power (at the waveguide flange)	+10 dBm, nominal
VSWR (75 GHz to 81 GHz, at the waveguide flange)	2:1, nominal
TX	
Connector	WR-12, UG387/U, horizontal polarization
Maximum Tx output power (at the waveguide flange)	+7 dBm, nominal
Tx to Rx antenna isolation	≥80 dB, measured[1]

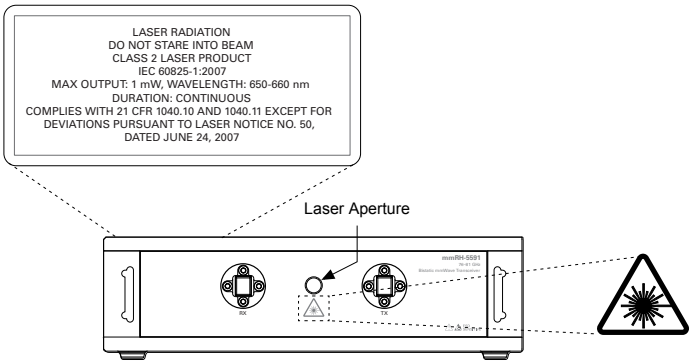
Alignment Laser Specifications

Laser class	2
Wavelength	650 nm to 660 nm
Beam divergence	1.2 mrad
Duration	Continuous
Maximum power	1 mW

Caution This is a Class 2 (Class II) laser product and has visible laser radiation up to 1 mW emitting from the laser aperture. This product is for use as an alignment laser only, per CFR Title 21, Chapter I, Subchapter J, Part 1040.11(b). The product is safe for momentary exposures but can be hazardous for deliberate staring into the beam. DO NOT STARE INTO THE BEAM. Class 2 lasers can cause photochemical and thermal retinal injury to the eye, as well as skin reactions and burns with longer than momentary exposure. Adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Dazzle, flash-blindness and afterimages may be caused by a beam from a Class 2 laser product, particularly under low ambient light conditions. This may have indirect general safety implications resulting from temporary disturbance of vision or from startle reactions. Such visual disturbances could be of particular concern connected with performing safety-critical operations such as working with machines or at height,

[1] Describes a radio head with 14 dBi antennas (part number 787550-01) and the plastic front panel covering with integrated microwave absorber attached.

with high voltages, or driving. Users are instructed not to stare into the beam, and should perform active protective reactions by moving the head or closing the eyes and to avoid continued intentional intrabeam viewing.



Object Simulation

Number of objects	1 to 4 per radio head[2]
Instantaneous bandwidth	4 GHz
Frequency bands	
Band 1	76 GHz to 80 GHz
Band 2	77 GHz to 81 GHz

Table 1. Additive Phase Noise, 79 GHz at 100 kHz Offset, Measured

Distance (m)	Phase Noise (dBc/Hz)
3	-95
50	-95
100	-92
150	-90
200	-88

[2] Specifications apply to configurations with 1 to 2 objects per radio head. System is capable of simulating up to 4 objects per radio head.

Table 1. Additive Phase Noise, 79 GHz at 100 kHz Offset, Measured (Continued)

Distance (m)	Phase Noise (dBc/Hz)
250	-86
300	-85

Setup distance	0.7 m to 3.0 m
Distance[3]	
Shortest simulated distance	2.5 m + setup distance[4]
Longest simulated distance	300 m
Distance resolution	5 cm, nominal
Distance accuracy (at the waveguide flange, 18 °C to 28 °C)	
Distances ≤100 m	±4 cm, typical
Distances >100 m	±7 cm, typical
Distance temperature drift (at the waveguide flange, 23 °C ± 5 °C)	
Distances ≤100 m	±1 cm, measured
Distances >100 m	±2 cm, measured
Radar cross section (RCS) (at the waveguide flange)[3]	
RCS range	127 dB (-41 dBsm to 86 dBsm), nominal[5]
Maximum RCS gain	18 dB, nominal
RCS dynamic range	50 dB
RCS resolution	0.25 dB, nominal
RCS accuracy	±4 dB, typical, 18 °C to 28 °C
RCS temperature drift	±1 dB, measured, 23 °C ± 5 °C
Doppler	
Doppler range	0 to ±500 km/hr (75 kHz), nominal
Doppler resolution	0.1 km/hr (15 Hz), nominal
Doppler accuracy	±0.05 km/hr (7.5 Hz), nominal

[3] Average across 4 GHz bandwidth. Measured at IF2 with waveguide loopback connected between the Rx and Tx waveguide flanges. Unused IF ports capped with 50 Ω terminations.

[4] This simulated distance applies to the PXIe-5551 connected to the mmRH-5591. Add 0.5 m for each additional PXIe-5551 in the system.

[5] Describes the RCS range for the first PXIe-5551 cabled to the mmRH-5591 for a system with 14 dBi antennas (part number 787550-01) and a 1 m setup distance.

Measurements with the PXIe-5841

Frequency bands	
Band 0	75 GHz to 79 GHz
Band 1	76 GHz to 80 GHz
Band 2	77 GHz to 81 GHz
Band 3	78 GHz to 82 GHz
Absolute power measurement accuracy (at the waveguide flange)	±2.5 dB, typical, 18 °C to 28 °C
Power measurement temperature drift (at the waveguide flange)	±1 dB, measured, 23 °C ± 5 °C

Connector Descriptions

mmRH-5591 Connectors

RX	
Connector	WR-12, UG387/U, horizontal polarization
Recommended maximum input power (at the waveguide flange)	-13 dBm
Absolute maximum input power (at the waveguide flange)	+10 dBm, nominal
VSWR (75 GHz to 81 GHz, at the waveguide flange)	2:1, nominal
TX	
Connector	WR-12, UG387/U, horizontal polarization
Maximum Tx output power (at the waveguide flange)	+7 dBm, nominal
RX IF2 OUT	
Connector	SMA (female)
RX IF1 OUT	
Connector	SMA (female)
TX IF1 IN	
Connector	SMA (female)
Input impedance	50 Ω, nominal

Recommended maximum input power	-3 dBm
Absolute maximum input power	+10 dBm, nominal
TX IF2 IN	
Connector	SMA (female)
Input impedance	50 Ω, nominal
Recommended maximum input power	-3 dBm
Absolute maximum input power	+10 dBm, nominal
Gain from mmRH-5591 TX IF2 IN to mmRH-5591 TX (at the waveguide flange)	+10 dB, nominal
Frequency range	1.8 GHz to 5.8 GHz[6]
10 MHz REF IN	
Connector	SMA (female)
Input impedance	50 Ω, nominal
Recommended input power	0 dBm to +10 dBm, nominal
Absolute maximum input power	+15 dBm, nominal
Frequency	10 MHz
Tolerance	$\pm 10 \times 10^{-6}$
10 MHz REF OUT	
Connector	SMA (female)
Frequency	10 MHz, nominal
Output power	+7dBm, nominal
12 V 3.0 A MAX	
Connector	Two-pin custom
DIO	
Connector	Mini HDMI

PXIe-5551 Connectors

REF IN	
Connector	MMPX (female)
Input impedance	50 Ω, nominal
Recommended input power	+0 dBm to +10 dBm, nominal

[6] There is a spectral inversion from mmRH-5591 TX IF2 IN to mmRH-5591 TX.

Absolute maximum input power	+15 dBm, nominal
Frequency	10 MHz
Tolerance	$\pm 10 \times 10^{-6}$
REF OUT	
Connector	MMPX (female)
Frequency	10 MHz, nominal
Amplitude	+10 dBm, nominal
RX IF2 IN	
Connector	SMA (female)
Input impedance	50 Ω, nominal
Recommended maximum input power	-3 dBm
Absolute maximum input power	+10 dBm, nominal
RX IF2 OUT	
Connector	SMA (female)
Gain from mmRH-5591 RX (at the waveguide flange) to PXIe-5551 RX IF2 OUT	+10 dB, nominal
Frequency range	1.8 GHz to 5.8 GHz[7]
TX IF1 IN	
Connector	SMA (female)
Input impedance	50 Ω, nominal
Recommended maximum input power	-3 dBm
Absolute maximum input power	+13 dBm, nominal
TX IF1 OUT	
Connector	SMA (female)
DIO	
Connector	Mini HDMI
PFI 0	
Connector	SMA (female)
PFI 1	
Connector	SMA (female)

[7] There is a spectral inversion from mmRH-5591 RX to PXIe-5551 RX.

Environmental Characteristics

The following specifications apply to the mmRH-5591 and PXIe-5551. Refer to individual product specifications for other system components.

Temperature and Humidity

Temperature	
Operating with PXIe-5841	
Chassis with slot cooling capacity ≥58 W[8]	0 °C to 55 °C
All other compatible chassis[9]	0 °C to 40 °C
Operating without PXIe-5841	0 °C to 55 °C
Storage	-40 °C to 71 °C
Humidity	
Operating	10% to 90%, noncondensing
Storage	5% to 95%, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Shock and Vibration

Random vibration	
Operating	5 Hz to 500 Hz, 0.3 g RMS
Non-operating	5 Hz to 500 Hz, 2.4 g RMS
Shock	
Operating	30 g, half-sine, 11 ms pulse
Non-operating	50 g, half-sine, 11 ms pulse

[8] Tested with chassis fan mode set to Auto and cooling profile set to 58 W/82 W in NI MAX. Not all chassis with slot cooling capacity ≥58 W can achieve this ambient temperature range. Refer to PXI Express chassis specifications to determine the ambient temperature ranges your chassis can achieve.

[9] For chassis with slot cooling capacity = 38 W, the fan speed must be set to HIGH to achieve this ambient temperature range.

Physical Characteristics

Table 2. VRTS with 4 GHz Bandwidth Physical Characteristics, Nominal

Module	Dimensions	Weight (kg)
mmRH-5591	21.9 cm × 15.5 cm × 9.9 cm	3.0
PXIe-5551	2 slots	1.1

Figure 1. mmRH-5591 Mechanical Dimensions, Top View

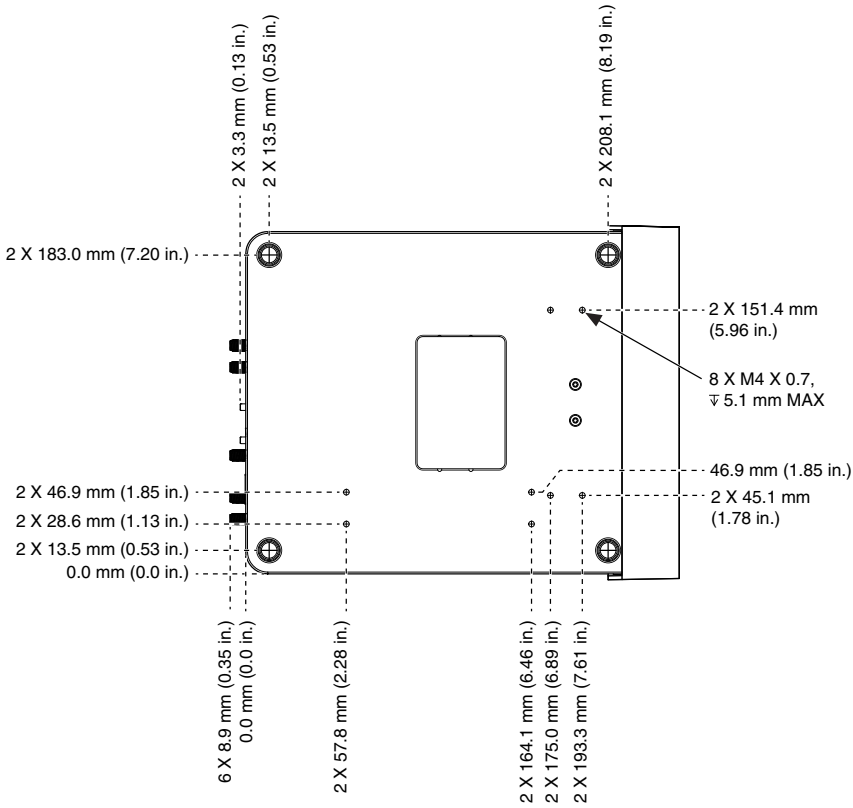
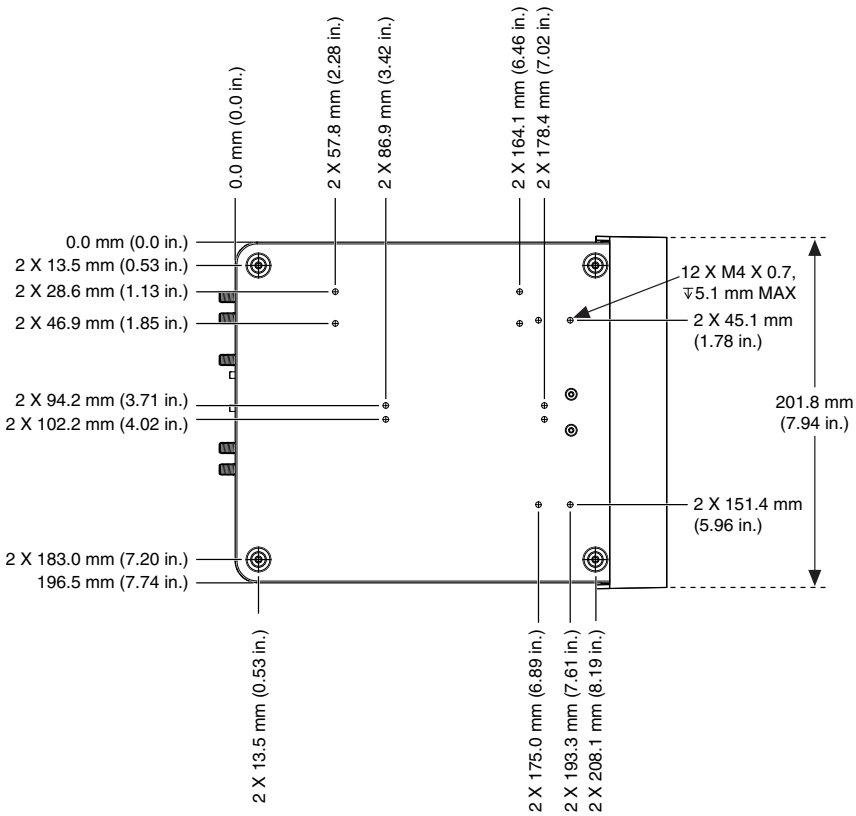


Figure 2. mmRH-5591 Mechanical Dimensions, Bottom View



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